

# Online appendix for Seasonal Farm Labor and Risk of COVID-19 Spread

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In the main analysis, I proxy for FLC employment using the county share of contract labor expenditures in the state according to the 2017 Agricultural Census interacted with the number of FLC workers at the state-month in the 2019 QCEW. As a robustness check, I repeat the analysis using the number of FLC workers in the county-month as recorded directly in the QCEW. Results are reported in tables 1 and 2. Findings are similar to those in main tables, though the coefficients are somewhat smaller using the county FLC counts from the QCEW. Most notably, the coefficients on FLC employment in table 2 are not statistically significant in 2 out of the 3 specifications.

I next repeat the analysis extending the sample period from April–December, controlling for county-specific trends, and dropping counties with large post-secondary institutions (institutions with enrollment of at least 10,000 students). I use 2018 monthly employment and labor force data in this analysis due to limited data in the latter months of 2019. However, historical monthly variation in employment should be similar between 2018 and 2019. Results are reported in tables 3 and 4,<sup>1</sup> and are similar to the main results.

I additionally repeat the analysis using a number of robustness checks due to concerns about urban influence on COVID-19 spread, data suppression in the 2019 QCEW, and potential correlation between crop employment and workplace COVID-19 outbreaks in meat processing plants. First, one might be concerned that exposure to rapidly spreading COVID-19 incidence in urban areas influences the results. As a robustness check, I limit the sample to rural (non-metropolitan) counties.<sup>2</sup> Figure 1 shows the geographic distribution of rural counties in a U.S. map. Results using rural counties only are reported in panel A of table 5. The estimated coefficients on FVH employment are statistically significant in all three specifications and slightly larger than in the corresponding table in the main text.

The QCEW suppresses employment data when there are few employers within a county-month observation or when it might be possible to identify a single firm using the county aggregated data. In the main analysis, I replace suppressed employment with zero employment since in most cases, there are likely relatively few workers in the suppressed sector of employment. However, as a robustness check, I drop all counties with suppressed

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<sup>1</sup>Note, I drop the controls for April COVID-19 exposure interacted with month fixed effects since the estimating matrix with county trends is so large.

<sup>2</sup>Rural classification is based on the Office of Management and Budget (OMB) 2013 Urban Influence Codes.

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data in any one of the FVH sectors of interest. A map of the counties retained after dropping suppressed employment data is in figure 2. The results after dropping counties with suppressed FVH or FLC employment are in panel B of table 5. Coefficients for the association between FVH employment and new COVID-19 case incidence in columns 1-4 are quite a bit larger than in the main results but qualitatively similar.

In panel C of table 5, I additionally drop observations from Florida, Georgia, and North Carolina since these states have a high share of H-2A workers who are not reported in the QCEW. Results are similar to those in panel B and qualitatively similar to those in the main results.

In panel D, I drop all counties with positive employment in meat packing plants (or suppressed employment data for the meat packing sector). I do not control for employment in meat packing plants in the main analysis because there is little month-to-month variation in employment. However, one might be concerned that worksite outbreaks of COVID-19 in rural meat packing plants in 2020 might correlate with changes in FVH employment and thus bias results. Figure 3 shows which counties were retained after dropping those with meat processing employment. The results in panel D are similar to those in the main results, suggesting that COVID-19 outbreaks in meat processing plants had little correlation with monthly variation in historical FVH employment.

# Seasonal Farm Labor and Risk of COVID-19 Spread

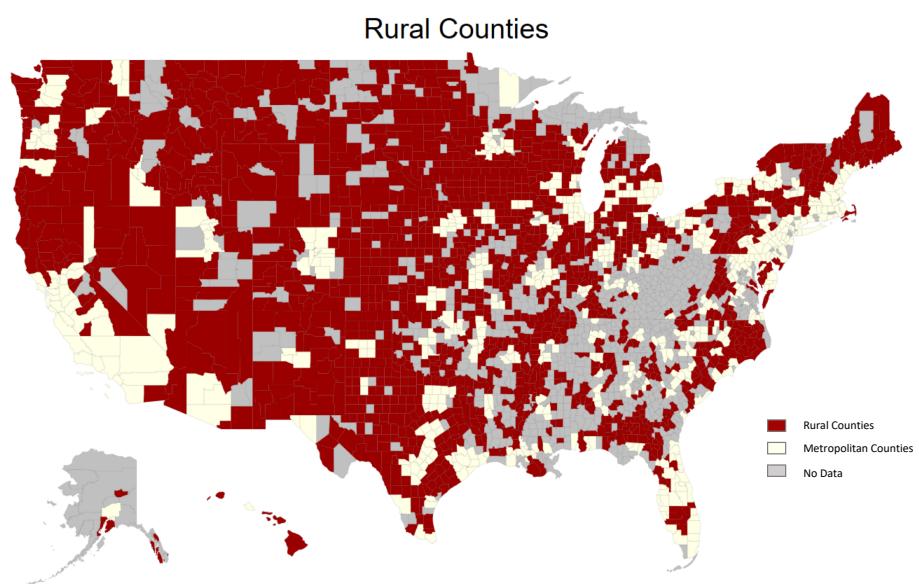


Figure 1: Designated rural counties

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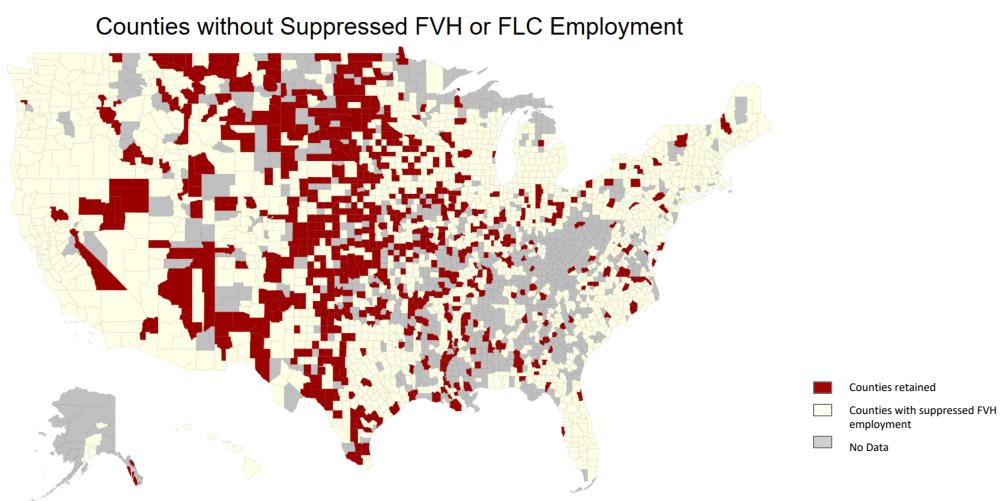


Figure 2: Counties without FVH employment suppression

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Figure 3: Counties without employment in meat processing

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Table 1: Robustness: FVH relation to COVID-19 using QCEW county-month FLC counts

	(1) arcsinh(Cases)	(2) arcsinh(Cases)	(3) Cases per 100,000	(4) Cases per 100,000	(5) Deaths per 100,000	(6) Deaths per 100,000
2019 monthly employment measured in hundreds of workers						
FVH	0.007*** (0.003)	0.008*** (0.003)	8.647*** (2.408)	9.533*** (2.853)	0.133*** (0.054)	0.207*** (0.061)
Post Harvest Activities	-0.007 (0.008)	-0.007 (0.008)	-1.267 (10.975)	1.267 (10.975)	-0.310 (0.264)	-0.310 (0.264)
Construction	0.010 (0.009)	0.010 (0.009)	47.051** (9.541)	47.051** (9.541)	1.273** (0.276)	1.273** (0.276)
Retail Trade	0.003 (0.006)	0.003 (0.006)	-1.335 (5.698)	-1.335 (5.698)	0.188 (0.200)	0.188 (0.200)
Accommodation & Food	0.004 (0.003)	0.004 (0.003)	-0.052 (2.956)	-0.052 (2.956)	-0.086 (0.089)	-0.086 (0.089)
County Fixed Effects						
State-by-Month FE	Y	Y	Y	Y	Y	Y
April Exposure-by-Month FE	Y	Y	Y	Y	Y	Y
Observations	11140	11140	11035	11035	11035	11035
R-Squared	0.649	0.650	0.314	0.318	0.236	0.239

Robust standard errors clustered at the county. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. arcsinh is the inverse hyperbolic sine transformation. Employment by industry is measured in hundreds of workers at the county-month. FVH employment includes employment on orange groves, citrus groves, greenhouse, nursery, and floriculture production, vegetable and melon farming, apple orchards, grape vineyards, strawberry farming, other berry farming, fruit and tree nut combination farming, and other non-citrus fruit production (NAICS 11131, 11132, 11131, 11132, 11133, 11133, 111334, 111336, and 111339), and FLCs. FLCs are employees of Farm Labor Contractors (NAICS 115115). All specifications include county fixed effects, state-by-month fixed effects, and an indicator variable for level of COVID-19 exposure in April 2020 interacted with month fixed effects.

## Seasonal Farm Labor and Risk of COVID-19 Spread

Table 2: Robustness: Crop industry relation to COVID-19 using QCEW county-month FLC counts

	(1) arcsinh(Cases)	(2) Cases per 100,000	(3) Deaths per 100,000
2019 monthly employment measured in hundreds of workers			
Strawberries	0.002 (0.007)	-2.839 (7.437)	0.074 (0.184)
Other Berries	0.007 (0.006)	8.825 (6.543)	0.228 (0.160)
Grapes	0.002 (0.014)	48.237* (24.908)	0.895** (0.394)
Other Noncitrus Fruit	0.019*** (0.007)	23.961*** (5.657)	0.445*** (0.150)
Citrus Employment	-0.065 (0.071)	-281.032 (188.159)	-1.984 (2.154)
Vegetables & Melons	0.020 (0.015)	21.525 (17.022)	0.020 (0.694)
Greenhouse	0.305** (0.155)	332.301* (193.620)	9.483* (5.037)
Floriculture & Nursery	0.018 (0.032)	-11.418 (53.455)	-0.979 (1.247)
Grain & Oilseed	0.060 (0.115)	129.766 (104.190)	1.315 (2.733)
Other Crops	0.084 (0.061)	67.597 (53.562)	0.389 (0.976)
Animals & Livestock	-0.046 (0.042)	-62.942 (55.198)	-2.056 (1.396)
Farm Labor Contractor	0.006 (0.004)	4.251 (5.209)	0.119 (0.086)
Post Harvest Activities	-0.010 (0.009)	-2.391 (10.294)	-0.394 (0.258)
Construction	0.009 (0.009)	46.760*** (9.621)	1.269*** (0.277)
Retail Trade	0.002 (0.006)	-1.903 (5.748)	0.174 (0.197)
Accommodation & Food	0.004 (0.003)	0.316 (3.007)	-0.078 (0.089)
County Fixed Effects	Y	Y	Y
State-by-Month FE	Y	Y	Y
April Exposure-by-Month FE	Y	Y	Y
Observations	11140	11035	11035
R-Squared	0.650	0.319	0.239

Robust standard errors clustered at the county. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. arcsinh is the inverse hyperbolic sine transformation. Employment by industry is measured in hundreds of workers at the county-month. FLC workers are employees of Farm Labor Contractors (NAICS 115115). All specifications include county fixed effects, state-by-month fixed effects, and an indicator variable for level of COVID-19 exposure in April 2020 interacted with month fixed effects.

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**Table 3: Robustness: FVH relation to COVID-19 from April-December, controlling for county trends**

	(1) arcsinh(Cases)	(2) arcsinh(Cases)	(3) Cases per 100,000	(4) Cases per 100,000	(5) Deaths per 100,000	(6) Deaths per 100,000
2019 monthly employment measured in hundreds of workers						
FVH	0.010** (0.005)	0.013*** (0.005)	8.992** (3.546)	8.063* (4.801)	-0.022 (0.097)	-0.125 (0.140)
Post Harvest Activities		-0.025 (0.017)		1.543 (18.036)		0.434 (0.617)
Construction		0.006*** (0.002)		4.073 (9.157)		0.605* (0.332)
Retail Trade		0.010* (0.006)		7.979 (8.915)		-0.224 (0.288)
Accommodation & Food		0.007** (0.003)		4.512 (2.773)		0.244** (0.106)
County Fixed Effects	Y	Y	Y	Y	Y	Y
County Trends	Y	Y	Y	Y	Y	Y
State-by-Month FE	Y	Y	Y	Y	Y	Y
Observations	17424	17424	17244	17244	17244	17244
R-Squared	0.841	0.841	0.730	0.730	0.456	0.456

Robust standard errors clustered at the county. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. arcsinh is the inverse hyperbolic sine transformation. Employment by industry is measured in hundreds of workers at the county-month. FVH employment includes employment on orange groves, citrus groves, greenhouse, nursery, and floriculture production, vegetable and melon farming, apple orchards, grape vineyards, strawberry farming, other berry farming, fruit and tree nut combination farming, and other non-citrus fruit production (NAICS 11131, 11132, 11141, 11142, 1112, 11131, 111332, 111334, 111336, and 111339), and FLCs. FLCs are employees of Farm Labor Contractors (NAICS 115115). All specifications include county fixed effects, county trends, and state-by-month fixed effects. All specifications drop counties with a post-secondary school with enrollment of 10,000 or more students.

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Table 4: Robustness: Crop industry relation to COVID-19 from April-December, controlling for county trends

	(1) arcsinh(Cases)	(2) Cases per 100,000	(3) Deaths per 100,000
2019 monthly employment measured in hundreds of workers			
Strawberries	0.195 (0.282)	56.401 (179.949)	4.034 (4.303)
Other Berries	0.006 (0.007)	-2.551 (6.330)	0.121 (0.307)
Grapes	0.030 (0.034)	63.953 (45.930)	0.396 (0.753)
Other Noncitrus Fruit	0.015** (0.006)	7.520 (6.798)	0.039 (0.142)
Citrus Employment	-0.000 (0.130)	-100.107 (306.623)	0.852 (5.673)
Vegetables & Melons	0.015 (0.018)	23.737 (21.461)	-1.017 (0.960)
Greenhouse	-0.050 (0.190)	-259.863 (167.234)	1.761 (6.055)
Floriculture & Nursery	0.005 (0.024)	5.855 (25.617)	0.148 (0.808)
Grain & Oilseed	-0.099 (0.069)	-70.806 (131.982)	-1.765 (3.775)
Other Crops	-0.024 (0.017)	-32.175 (27.917)	-0.427 (0.658)
Animals & Livestock	0.025 (0.049)	8.347 (57.426)	-3.295 (2.109)
Farm Labor Contractor	0.019 (0.016)	10.628 (19.618)	0.080 (0.528)
Post Harvest Activities	-0.030* (0.017)	0.523 (20.496)	0.201 (0.444)
Construction	0.006*** (0.002)	4.068 (9.231)	0.615* (0.333)
Retail Trade	0.009 (0.006)	6.671 (8.990)	-0.182 (0.304)
Accommodation & Food	0.007** (0.003)	4.753* (2.828)	0.243** (0.110)
County Fixed Effects	Y	Y	Y
County Trends	Y	Y	Y
State-by-Month FE	Y	Y	Y
Observations	17424	17244	17244
R-Squared	0.841	0.730	0.456

Robust standard errors clustered at the county. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. arcsinh is the inverse hyperbolic sine transformation. Employment by industry is measured in hundreds of workers at the county-month. FLC workers are employees of Farm Labor Contractors (NAICS 115115). All specifications include county fixed effects, county trends, and state-by-month fixed effects,.s. All specifications drop counties with a post-secondary school with enrollment of 10,000 or more students.

Table 5: Additional robustness checks

	(1) arcsinh(Cases)	(2) arcsinh(Cases)	(3) Cases per 100,000	(4) Cases per 100,000	(5) Deaths per 100,000	(6) Deaths per 100,000
2019 monthly employment measured in hundreds of workers						
FVH	0.028*** (0.008)	33.580*** (0.011)	33.580*** (7,241)	32.653*** (9,467)	0.354*** (0.165)	0.423* (0.236)
Observations	7975	7975	7975	7975	7975	7975
R-Squared	0.631	0.635	0.302	0.304	0.207	0.208
A. Rural Counties Only						
FVH	0.036*** (0.008)	33.580*** (0.011)	33.580*** (7,241)	32.653*** (9,467)	0.354*** (0.165)	0.423* (0.236)
Observations	7975	7975	7975	7975	7975	7975
R-Squared	0.631	0.635	0.302	0.304	0.207	0.208
B. Drop Counties with Suppressed Employment in Any FVH Sector (Including FLCs)						
FVH	0.142*** (0.034)	134.997*** (0.048)	134.997*** (33,523)	133.526*** (43,633)	0.981 (0.902)	2.956** (1,371)
Observations	3333	3333	3320	3320	3320	3320
R-Squared	0.636	0.640	0.336	0.339	0.249	0.251
C. Drop Counties with Suppressed Employment and States with High Number of Unreported H-2A						
FVH	0.121*** (0.032)	0.156*** (0.045)	137.772*** (34,698)	141.446*** (44,235)	1.129 (0.832)	3.714*** (0.967)
Observations	3201	3201	3188	3188	3188	3188
R-Squared	0.636	0.640	0.332	0.336	0.239	0.242
D. Drop Counties with Positive or Suppressed Employment in Meat Processing						
FVH	0.017*** (0.005)	0.021*** (0.006)	16.997*** (6,551)	20.589*** (7,592)	0.293*** (0.139)	0.312** (0.144)
Observations	7815	7815	7787	7787	7787	7787
R-Squared	0.656	0.658	0.298	0.300	0.210	0.211
Non-Farm Employment Controls	N	Y	N	Y	N	Y
County Fixed Effects	Y	Y	Y	Y	Y	Y
State-by-Month FE	Y	Y	Y	Y	Y	Y
April Exposure-by-Month FE	Y	Y	Y	Y	Y	Y

Robust standard errors clustered at the county. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. arcsinh is the inverse hyperbolic sine transformation. Employment by industry is measured in hundreds of workers at the county-month. FVH employment includes employment on orange groves, citrus groves, greenhouse, nursery, and floriculture production, vegetable and melon farming, apple orchards, grape vineyards, strawberry farming, other berry farming, fruit and tree nut combination farming, and other non-citrus fruit production (NAICS 11131, 11132, 11132, 11133, 11133, 11133, 11133, 11133, and 111339) and FLCs. FLCs are employees of Farm Labor Contractors using the proxy calculated from the 2017 Agricultural Census county share of contract labor expenditures in the state interacted with the QCEW number of FLC employees in the state in 2019 (NAICS 115115). All specifications include county fixed effects, state-by-month fixed effects, and an indicator variable for level of COVID-19 exposure in April 2020 interacted with month fixed effects. Even columns include controls for employment in non-farm industries with potential seasonal changes in labor demand, including construction (NAICS 23), retail trade (NAICS 44-45), and accommodation and food (NAICS 72).